Supporting Remote Caregiver Input for Home Assessments

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ABSTRACT

Previous work has shown that remote home assessments can save occupational therapists (OTs) significant travel time. However, existing methods of remote, digital home assessment often rely on trained para-professionals to document the home environment so that remote OTs can analyze the data. In this study, we examine how we might enable non-expert caregivers to document the home environment for remote assessment. We conducted participatory design sessions with occupational therapists to understand their expertise and the nature of the desired information to support their judgment. Results showed that OTs require home environment data to offer situational awareness, a shared conversation space, precise measurements, and an understanding of how a patient interacts with the objects in the home. We present HomeAx, an app prototype that enables remote home assessments via a combination of guided photos, videos, annotation, and supported conversations.

INTRODUCTION

Home assessments are indicated when a patient has heightened fall risk at home due to a loss of mobility or functionality. During a home assessment, an expert, usually an Occupational Therapist (OT), assesses the unique physical setup of the home in order to a) minimize fall risk, and b) to maximize occupational functionality for the patient. A home assessment usually ends with a to-do list for caregivers, with items such as installing grab bars or re-organizing shower areas for independent bathing. When completed, these modifications have been shown to be effective in decreasing the risk of home injuries among the physically impaired, especially for older adults [1, 5]. A randomized controlled trial done with 842 households found a 26% reduction in rate of falls among older people living at home when a home-safety assessment was done with subsequent modification interventions [2].

Despite the clear benefits of home assessments, they are seldom conducted due to cost limitations [1]. Even in geographically small Singapore, where this study was conducted, the time to travel to a patient's home can be an hour. Including reporting activities, one home assessment can take half a working day. As a result, over-burdened hospitals have had to limit offering such services. .

LITERATURE REVIEW

Technology to enable remote expert assessment is a likely method to address the travel and documentation challenge. Previous research on remote systems to enable health experts to guide community health workers showed that support for situational awareness and interaction techniques for remote

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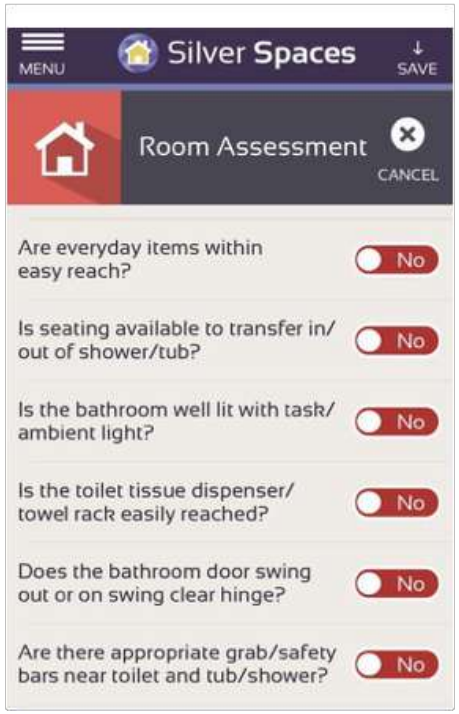

Figure 1: Silver Spaces application showing questions for caregivers

Table 1: Therapists participating in the study

OT's Hospital Type	n	Total Experience
Acute	4	18 years
Acute and Rehab	3	5 years

guidance are two key components of such work [3, 4]. However, these remote synchronous communications often call for specialized hardware that must be somehow delivered to the field site. Utilizing remote hardware is not viable in the case of home assessments, since eliminating travel to multiple sites is a key cost saving. Thus, this design context constrains us to more commonly available hardware such as tablets.

In the related health services literature, researchers have proposed that patients' caregivers can be operators of the hardware to gather data on the home environment. Daniel et. al. compared home hazards identified between a regular on-site home assessment, and one conducted by OTs using photographs and measurements taken by patients' caregivers [1]. This PhoHA method proved to be almost as useful as the ideal case method (on-site therapist) and reduced monetary costs by 53% in the study.

The researchers suggested that an additional benefit of involving caregivers was that their input could improve the compliance rate of the patients to the recommended modification [1], although this was not tested in the study. Other researchers studying compliance to modification recommendations pointed out the need for a further interaction - a medium that helps stakeholders to "visually communicate complex ideas and solutions" [5]. Thus, there seems to be an unmet need to develop systems that support the resulting conversation between caregivers who represent patient preferences, and OTs who make recommendations about home modifications.

The PhoHA method also reported some limitations. Some risks, such as slippery surfaces, walking pathways and occluded views in rooms could not be properly documented through still images. Furthermore, still images did not aid in understanding the patients' interactions with the home environment, which is important for occupational adaptation of impaired persons. To our knowledge, the possibility of video-based methods for this purpose have not yet been explored.

Commercial products for home assessment exist, e.g.Silver Spaces (Fig. 1). However, these apps pose questions that require expert judgment to assess the environmental hazard. For example, Silver Spaces asks "Are there appropriate grab/safety bars near toilet and tub/shower?" without explaining what a better, alternative grab bar placement should be (Fig. 1). Furthermore, it is unlikely that caregivers that are non-experts can assess if the grab bars are occupationally 'appropriate' for the patients unique needs.

Hence, in this study, we conducted participatory design sessions with OTs to understand the requirements of a system that utilizes non-expert, caregiver input to document the home environment. We wanted to understand how to use a system to guide caregivers to create good enough documentation for the OTs to remotely assess the home.

We chose a participatory design approach and worked with hospital-based OTs over four sessions (see Table 1 for participants' information).

Figure 2: Sample of OTs hand-written annotations on photo of a toilet area, showing the therapists' common pattern of drawing an arrow and then commenting on the area indicated by the arrow.

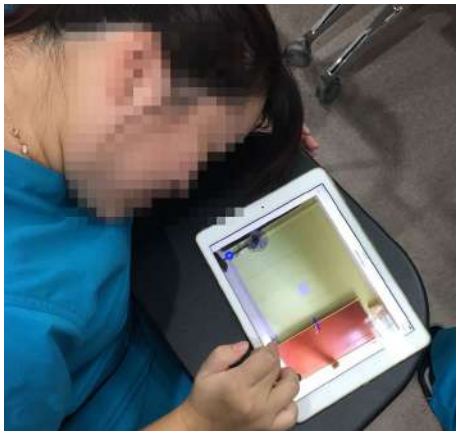

Figure 3: OT measuring a door height on the prototype, while struggling locate the edge of the door occluded by her finger.

We developed an initial iOS application that consisted of questions from an existing paper-based home assessment checklist. Different to the paper-based checklist, we guided the user to take several photos of rooms in a home. Since the literature showed a requirement for a shared space for annotation of environment data, this early prototype enabled therapists to annotate the photos with text and sketch markup. A third feature was a measurement tool for estimating the height/width of objects in a photo, using a reference-calibrated technique.

METHOD AND MATERIALS

The sessions with OTs were two-hour participatory design sessions. First, we sought to understand current practice for using paper form-based methods. Then, we gave the OTs patient personas ("wheelchair-bound" and "ambulant but frail") and requested them to annotate photo printouts of toilets for each of these patient types (Fig. 2). Then, we asked the OTs to complete 2 tasks on the iOS app while we observed and recorded user behaviours. The two tasks were to take a photo of a dining area in the pantry, and then to annotate that photo as if conducting an assessment for a seated patient who is having a meal.

Finally, to understand how OTs derive situational awareness of a remote home, we encouraged the OTs to experiment with two possible interaction techniques. One was a 2D, map-based method of understanding the location of each photo in the home (similar to Google Maps), and the second was a 360 degree photo-taking app called Bubbli.

After Session 1, we iterated new prototypes. Ideas were discussed with OTs by phone in the interim period. We then developed a graphic, low-fidelity prototype with Adobe XD which we presented to the OTs about a month later. During this session, Session 2, we walked the OTs through the proposed app and functions, and gathered further feedback.

FINDINGS

Session 1 Findings

Heavy User Burden. Our initial iOS application was a naive version of a pen-and-paper assessment protocol with 72 tasks. The OTs feedback was that a) this may be too heavy a task burden on the caregiver, since caregivers have many other caregiving duties to attend to simultaneously and b) OTs often conduct just a subset of these tasks, depending on the patients' needs. Thus, it would be wasted effort to require caregivers to document the entire home.

High Precision of Measurement. The current measuring system requires the caregiver to place an A4 paper in target scene, before the OT remotely calibrates digital measurements according to the paper. While attempting to measure on the touchscreen, the OTs struggled with finger occlusion. (Figure 3). It was difficult for them to accurately pin the start and end points of the measurement.

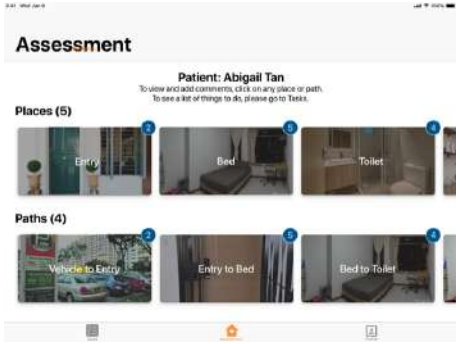

Figure 4: Main screen showing Places and Paths as a guide for caregivers

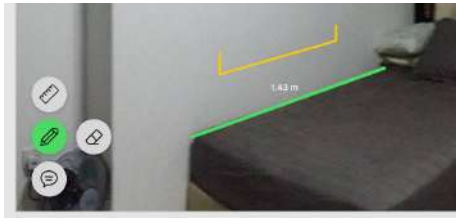

Figure 5: Example of annotation method that includes text, sketch and measuring functions

The OTs also requested for measurement precision. Our current attainable margin of error is 4cm but the OTs asserted a precision of 1cm is essential. For example, inaccurate measures of door widths might result in a wheelchair-bound patient not being able to enter rooms.

The Nature of Situational Awareness in Home Assessment. A Bubbli (https://bubb.li/) image is a dynamic spherical photo of the entire surroundings. After experimenting with this method of gaining contextual overviews of the home environment, OTs raised the potential concern of data safety as a 360 degree image covers the entire home, including areas not relevant to the patient. During the discussion, we discerned that the exact location of the room in the home is not important. Instead, seeing the path traveled, leading up to the room, was more critical to their understanding of the home environment and its potential hazards.

Support Needed for Communicating Outcomes. Currently, there is a sub-optimal process to share the modifications arising from home assessments. OTs communicate with the caregiver through email or phone call. Previously, requesting for and sending photos could be done on social messaging app, Whatsapp (https://www.whatsapp.com/), but it was stopped in order to comply with patient data privacy guidelines. However, when they moved the collaboration to email, our public hospital OTs were limited by the available data space for data-heavy images. In summary, in order to match their workflow, OTs requested a function to create reports of the assessment results.

HomeAx Prototype

Places, Paths and Participation (3P Model). Based on the feedback, we explored 2D map approaches and 3D approaches to improve situational awareness. We arrived at a guided interaction approach that combines videos and photos for the caregiver to document the home environment in ways that the OTs need to see. The requirement to optimize the tasklist was also taken into consideration. Each home is different, but there are locations of critical importance across every home. The collaboration with the OTs helped identify these locations as the home's entrance, bedroom and bathroom. Areas like the kitchen, living room and study room are of less importance. Hence, we decided to offer just 3 basic areas. OTs can later choose to add more areas for assessment according to each patient's needs. We developed a new prototype, HomeAx (Fig. 4). It consists of Places (guidance for caregivers to take images of rooms), Paths (guidance for videos while moving between Places), and Participation (guidance for videos of patient performing specified occupational activities). We called this the 3P model. After documentation, OTs can annotate the images for later sharing with caregivers (Fig. 5).

Platform for conversation. To facilitate and enhance communication of outcomes between the OT and the caregiver, we designed a conversational interface alongside the images and videos. In this

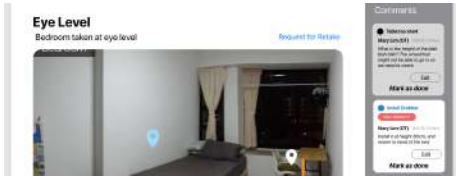

Figure 6: A conversational space to discuss the suggested modifications

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suggested interface, both the OT and caregiver can write and reply to comments tagged to individual images/video frames (Fig. 6).

Session 2 Findings

The feedback on the visual, low-fidelity prototype showed that it was an improvement from that of the initial naive prototype. However, the OTs were concerned about the conversation interface and its implications. The conversation interface opens up the option for the caregiver to ask questions. However, this had to be balanced against the OT's work burden, particularly as it enables out-of-scope questions. Additionally, reading in English poses a challenge to some caregivers in Singapore, since many of the older generation exclusively communicate in a variety of dialects. Therefore, we proposed the feature of a shared video call function within the application to reduce the reliance on English literacy.

CONCLUSION AND FUTURE WORK

This study contributes a user-centred design of HomeAx. Combining insights from the OTs and existing literature, we created a design of a digital home assessment application for remote caregivers and OTs to enable their partnership in home assessment. However, technical challenges remain for this application area, such as ensuring the precision of the measurement method using still images. In future work, we will implement and test HomeAx to assess its effectiveness against the gold-standard of an in-person site assessment.

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